A NEW CYSTOID (PELMATOZOA, ECHINODERMATA) FROM THE SILURIAN OF NEW SOUTH WALES.

By Ida A. Brown (Mrs. W. R. Browne).

(Plate xxi; two Text-figures.)

[Read 27th November, 1963.]

Synopsis.

The paper describes a cystoid (Pelmatozoa, Echinodermata) as a new genus and new species (*Austrocystites branagani*) from the Upper Silurian near Hatton's Corner, about two miles west of Yass, N.S. Wales. This is the first record of a cystoid from eastern Australia.

Introduction.

During a geological excursion to the Yass District with other senior students from the University of Sydney in 1949 Mr. (now Dr.) D. F. Branagan found a specimen of a peculiar cystoid which until now has not been critically examined.

Although "crinoidal" limestones and fragmentary remains of echinoderms are relatively common in Australia, complete specimens are very rare and there are remarkably few records of fossil Echinodermata, particularly from the Lower Palaeozoic.

Recently I have described a new species of *Cheirocrinus* (Rhombifera, Cystoidea) from the Ordovician of Emanuel Creek, in the Kimberley Division of Western Australia (Brown, 1963)—the first cystoid to be described from Australia—and given references to other recorded occurrences of non-crinoid Pelmatozoa from Australian Palaeozoic rocks, including forms described by Whitehouse (1941), Brown (1941*b*) and Gill and Caster (1960).

The Yass specimen to be described was collected from the top of the *Dalmanites* Bed, west of Hatton's Corner, about a quarter of a mile south of the Yass River and about two miles west of Yass. A map of the area and a description of the Silurian sequence near Yass have already been published (Brown, 1941*a*). The *Dalmanites* Bed is a calcareous sandstone, six to ten feet in thickness, whose outcrop forms low scarps and shallow dip-slopes on account of differential erosion. It was called the *Phacops* Bed by Jenkins (1878*a*, 1878*b*, 1879) and the Middle Trilobite Bed by Mitchell (1886–1924. See references in Brown, 1941*a*). It immediately overlies shales containing abundant graptolites, including *Monograptus bohemicus*, *M. nilssoni* and others equivalent to the *M. nilssoni* zone (33) of Great Britain, and is overlain by rocks containing *M. salweyi* of the *M. scanicus* zone (34) of Great Britain, thus fixing its age as Lower Ludlow (Brown and Sherrard, 1951).

The most abundant fossils in the *Dalmanites* Bed are *Dalmanites meridianus* Eth. & Mitchell, 1895, and *Streptelasma australe* (Foerste, 1888), but numerous other trilobites, small brachiopods and other fossils also occur (see list of fossils, Brown, 1941*a*), including a fragment of an echinoderm collected by Mitchell from his Middle Trilobite Bed in Bowning Village and described by him (Mitchell, 1897) as an echinoid, *Palaechinus* sp. (Aust. Museum Specimen, F.28030).

Mitchell's specimen contains also fragments of *Dalmanites* sp. and *Streptelasma* sp., proving his identification of its stratigraphical horizon, but I doubt his determination of *Palaechinus*. It is an external mould of portion of four rows of hexagonal plates of an echinoderm, showing fine ornamentation of granules with some larger tubercles;

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the latter are not boss-like, as in echinoids for the attachment of spines. As Mitchell's illustration of the specimen is a very inaccurate drawing, a photograph is now given on Plate xxi, fig. D. This shows that the specimen could be portion of a cystoid, such as *Holocystites* (*Megacystites*) *cylindricus* (Hall) from the Silurian of North America (Shimer and Shrock, 1948, Pl. 47, fig. 1). Its true identity must await the collection of additional material.

I wish to thank Mr. H. O. Fletcher of the Australian Museum for kindly allowing me to examine Mitchell's specimen.

Classification.

The classification of non-crinoid Pelmatozoa is still in an unsatisfactory state, although some clarification may be expected in the forthcoming "Treatise on Invertebrate Paleontology, Part S" (in press, 1963).

The earlier work of Jaekel (1899), Bather (1900, 1929) and others has been reconsidered more recently by Regnéll (1945), Moore (1954) and Gill and Caster (1960), but there are still certain forms—perhaps including the specimen described herein from Yass—that do not fit comfortably into any classification suggested so far. As pointed out by Moore (1954, p. 130) some diploporite cystoids show resemblances to other groups of echinoderms, either to edriasteroids or to blastoids, also some rhombiferid cystoids show certain likeness to regular eocrinoids or to blastoids, and yet others show affinities with camerate crinoids.

The usually accepted classification of the Cystoidea is based on the characters of the openings in the plates of the theca, which represent the positions of the breathing organs. Cystoids are thus divided into two Orders:

(1) Rhombifera, in which the breathing organs were in folds in the thecal wall, crossing the sutures of the plates, and usually arranged in pore-rhombs or pectinirhombs, and

(2) Diploporita, in which the breathing organs were enclosed in U-shaped canals within the plates and not crossing the sutures, when the surface openings appear as diplopores or "double pores".

The old Order—Amphorida—was discarded by Bather (1929) and is stated by Moore (1954, p. 127) to be "a heterogeneous assemblage which no longer is recognized".

Unfortunately the pores are not always easily discernible, nor, when present, are they always in pairs, some being single haplopores. Bather (1919, pp. 75–77, 111–115) discusses in considerable detail the structure of the pores in *Megacystis* (*Holocystites*), noting that (pp. 75, 76) "the pores are just the characters about which Miller and other American authors give least information". He also points out (p. 112) that sometimes the pores may be covered by a thin membrane or epistereom, when they will not be seen on a well-preserved surface.

The division of the Diploporita into families is based essentially on the character of the ambulacral region and the consequent modifications of the arrangement of the thecal plates.

Many of the cystoids have a large number of irregularly arranged plates, but some consist of relatively few plates, which may be arranged in circlets above a base or stem. In these the basal circlet usually contains only four plates; in a very few genera as many as eight plates may be present. Also the anal opening usually occurs above or between the plates of the second circlet, but rarely it occurs above the third circlet, as in *Caryocrinites* Say and possibly also in some species of *Eucystis* Angelin.

In attempting to place the new species from Yass it is found that the characters on which classification is usually based are either not shown in the specimen or are not such as are normally developed in other species.

In the general arrangement of the plates the Yass specimen shows resemblance to species of *Eucystis* as described by Regnéll (1945), and therefore is tentatively classed with *Eucystis* as a member of the Family Sphaeronitidae, in the Order Diploporita.

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Systematic Description.

Phylum ECHINODERMATA.
Subphylum PELMATOZOA.
Class CYSTOIDEA von Buch, 1846.
Order DIPLOPORITA J. Müller, 1954.
Family SPHAERONITIDAE Neumayr, 1889.

Genus Austrocystites, gen. n.

Type-Species: *Austrocystites branagani*, gen. n. et sp. n.

Diagnosis: Theca globular, composed of about 30 polygonal plates. Plates of the dorsal cup arranged in three circlets, the lower two each containing eight plates and the third circlet about six. Probably five oral plates. The anal opening distinct from the mouth and occurring above the third circlet. Ambulacral system unknown. Stem may be absent.

Stratigraphical Range: Upper Silurian (Lower Ludlow). Known only from the *Dalmanites* Bed of the Yass sequence, N.S. Wales.

Remarks: This genus appears to be closest to *Eucystis* Angelin, 1878. (Type species: *Eucystis raripunctata* Angelin, 1878.)

Three Ordovician species and one Lower Devonian (*Eucystis hercynica* Jaekel) are recorded by Jaekel (1899) and three new Ordovician and/or Lower Silurian species are described by Regnéll (1945). Regnéll redefined *Eucystis* as a genus of Sphaeronitidae with a rounded or elongated theca, composed of a moderate number of plates, arranged in three to five more or less irregular circlets. The pores are in pairs. There are four or five branching ambulacra, the longest grooves of which may extend into the circlet below the adoral one: anus apart from the mouth. Theca attached directly with a flat basal surface or a short stem. The number of plates in each circlet shows an irregular variation from 4 to 7, or in the case of *E. angelini* to 8 in the second circlet.

The new genus *Austrocystites* differs from *Eucystis* in the regular arrangement of eight plates in each of the two lower circlets. It differs also in geological age.

In the eightfold symmetry of the plates *Austrocystites* resembles one of the species of *Holocystites*, *H. greenvillensis* Foerste, 1917, from the Cedarville dolomite, Niagaran (Upper Silurian) of U.S.A. This species is more elongated than that of Yass, and has five circlets of eight plates, each of which is irregularly granulose. It differs from the Yass species in the structure of the adoral region.

Austrocystites branagani, gen. n. et sp. n. (Plate xxi; Text-figs 1, 2).

Holotype: Dept. of Geology and Geophysics, University of Sydney, Palaeontological Collection, Specimen No. 2301. Coll. D. F. Branagan, 1949.

Type Locality: A low ridge on the Middle Trilobite or *Dalmanites* Bed, about a quarter of a mile south of the Yass River, half a mile west of Hatton's Corner or two miles west of Yass, N.S. Wales.

Stratigraphical Position: Top of the *Dalmanites* Bed, Hume Series, Upper Silurian. Equivalent to Zone 33–34 of Lower Ludlow in Great Britain.

Diagnosis: As for the genus.

Description of the Holotype: The specimen is mainly an internal mould of the theca, on which are preserved portions of four of the original plates of crystalline calcite. Rock matrix covers the peristome and some of the adoral surface in such a way that further removal of matrix might damage the specimen. An isolated cystoid plate and a fragment of a trilobite occur in the matrix above the upper surface of the cystoid.

Photographs of three views of the theca are shown on Plate xxi, Figures A, B, C, and Text-figure 1 shows identification of the plates to correspond with these photographs.

The theca is globular, but has been somewhat distorted during preservation. The height is about 25 mm., the larger diameter about 24 mm. and that at right angles is 23 mm.: the thickness of the individual plates is approximately 0·6 mm. No stem

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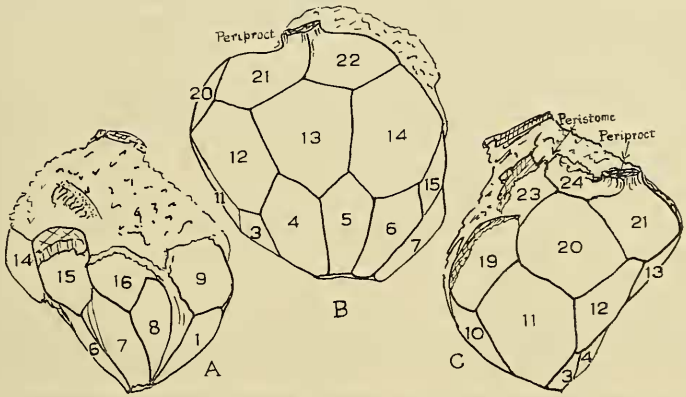
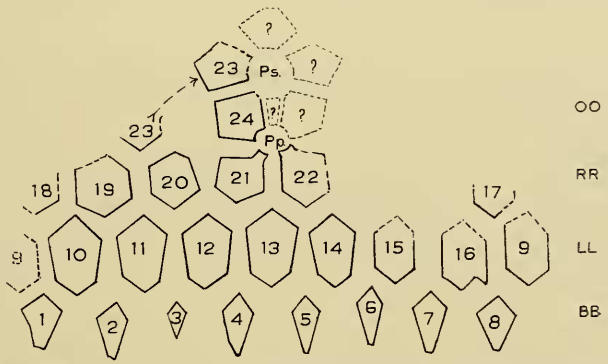


Text-fig. 1. *Austrocystites branagani* Brown, gen. n., sp. n.
Sketch of holotype in the position shown in the photographs, Plate xxi, figs A, B and C, to show the identifications of the plates corresponding with Text-fig. 2. A. Right lateral (near anterior), B. Posterior, and C. Left lateral views.

numbered 1 to 8, those of the second circlet 9 to 16, while the third circlet, of which only four (numbered 19 to 22) are exposed, probably contained six or seven plates. The mould of the periproct occurs as a tube 3·6 mm. in diameter above the third circlet, vertically above the suture of plates 21 and 22. Plates numbered 23 and 24 are two of probably five surrounding the peristome, and there is an indication that a small "anal" plate may occur between the periproct and the peristome, which is hidden under matrix.



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Diagrammatic analysis to show the structure and arrangement of the plates. Plates 1-8 (BB), first circlet; 9-16 (LL), second circlet; 17-22 (RR), third circlet; 23-24-? (OO), oral plates; Pp, periproct; Ps, peristome.

The plates of the basal circlet, 1–8, are arranged in the same manner as that shown by *Protocrinites oviformis* Eichwald and figured by Zittel (1900, fig. 300*b*), where the plate (here numbered 3) is smaller (4 mm. wide by 7 mm. high) than the others and does not reach the base. The remaining plates are all about 9 mm. high and vary in greatest width from 5 mm. to 8 mm.

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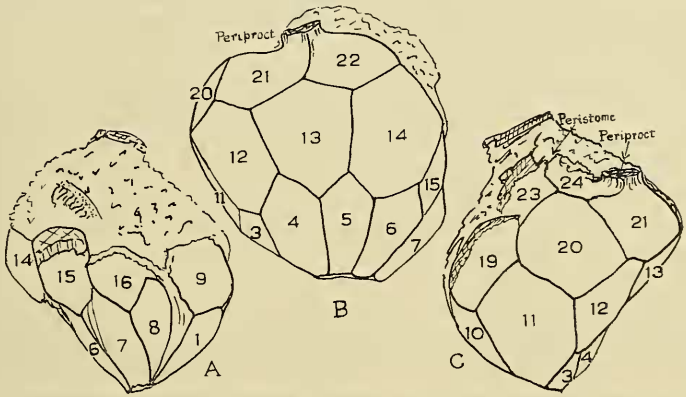

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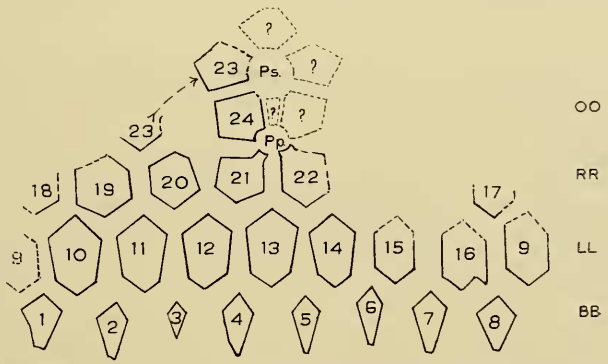

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Plates of the second circlet are all hexagonal, about 11 mm. in height and up to 9 mm. or 10 mm. wide towards the top.

Plates of the third circlet are either pentagonal or hexagonal, equidimensional and about 9 mm. in diameter.

All plates of the internal mould show well-preserved granulation of the surface, as shown on Plate xxi. The larger tubercles may contain pores, but I cannot distinguish diplopores; in places there seem to be single pores present. Although portions of several calcareous plates are present the type of preservation and weathering has masked the characters of the pores.

The ambulacra and possible brachioles are not revealed in the specimen.

Remarks: It is unfortunate that several of the characters on which classification of cystoids is based are not shown in this specimen. The general shape of the theca, the number of plates and the probable plan of the adoral surface (see Regnéll, 1945, p. 179, Fig. 22, 4*b*) suggest relationship with *Eucystis* Angelin, from which it differs, however, in the number of circlets, the number of plates in each circlet, the position of the periproct and possibly also the nature of the pores. Furthermore *Eucystis* is essentially an Ordovician genus.

The resemblance to one or more species of the Silurian cystoid *Holocystites* (Synn. *Megacystis*, *Megacystites*, *Trematocystis*) (see Bassler and Moodey, 1943) is based partly on the unusual feature of the plates being arranged in circlets of eight.

Holocystites (*Megacystis*) has been the subject of intense study by Foerste (1917, 1920) and also by Bather (1919). Although many of the species contain a great number of plates Foerste (1917, p. 233) considers that in some species, at least, it is possible to distinguish primary and secondary horizontal rows of plates (circlets), the primary rows always consisting of eight plates and the secondary ones of about 16 plates. In the species *H. greenvillensis* Foerste only the primary rows are developed, but it differs from *Austrocystites branagani* in its elongated shape and the presence of five circlets, each of eight plates (Foerste, 1917, Pl. ix, figs 3A, 3B, 3C).

Another species, *Megacystis ornatissimus* S. A. Miller, as figured by Bather (1919, p. 262, Pl. vi, fig. 25, after Miller, 1891), shows an adoral surface containing five oral plates and one anal plate above a circlet of six plates, with four ambulacra within the adoral circlet. *Austrocystites* may be similar. However, Bather proved the presence of diplopores in *Holocystites*.

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Plates of the second circlet are all hexagonal, about 11 mm. in height and up to 9 mm. or 10 mm. wide towards the top.

Plates of the third circlet are either pentagonal or hexagonal, equidimensional and about 9 mm. in diameter.

All plates of the internal mould show well-preserved granulation of the surface, as shown on Plate xxi. The larger tubercles may contain pores, but I cannot distinguish diplopores; in places there seem to be single pores present. Although portions of several calcareous plates are present the type of preservation and weathering has masked the characters of the pores.

The ambulacra and possible brachioles are not revealed in the specimen.

Remarks: It is unfortunate that several of the characters on which classification of cystoids is based are not shown in this specimen. The general shape of the theca, the number of plates and the probable plan of the adoral surface (see Regnéll, 1945, p. 179, Fig. 22, 4*b*) suggest relationship with *Eucystis* Angelin, from which it differs, however, in the number of circlets, the number of plates in each circlet, the position of the periproct and possibly also the nature of the pores. Furthermore *Eucystis* is essentially an Ordovician genus.

The resemblance to one or more species of the Silurian cystoid *Holocystites* (Synn. *Megacystis*, *Megacystites*, *Trematocystis*) (see Bassler and Moodey, 1943) is based partly on the unusual feature of the plates being arranged in circlets of eight.

Holocystites (*Megacystis*) has been the subject of intense study by Foerste (1917, 1920) and also by Bather (1919). Although many of the species contain a great number of plates Foerste (1917, p. 233) considers that in some species, at least, it is possible to distinguish primary and secondary horizontal rows of plates (circlets), the primary rows always consisting of eight plates and the secondary ones of about 16 plates. In the species *H. greenvillensis* Foerste only the primary rows are developed, but it differs from *Austrocystites branagani* in its elongated shape and the presence of five circlets, each of eight plates (Foerste, 1917, Pl. ix, figs 3A, 3B, 3C).

Another species, *Megacystis ornatissimus* S. A. Miller, as figured by Bather (1919, p. 262, Pl. vi, fig. 25, after Miller, 1891), shows an adoral surface containing five oral plates and one anal plate above a circlet of six plates, with four ambulacra within the adoral circlet. *Austrocystites* may be similar. However, Bather proved the presence of diplopores in *Holocystites*.

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EXPLANATION OF PLATE XXI.

Figs A-C. *Austrocystites branagani* Brown, gen. n. et sp. n.

Holotype. University of Sydney, Palaeontological Coll. Spec. No. 2301. Upper Silurian. Loc. half a mile west of Hatton's Corner, Yass Riv., two miles west of Yass, N.S.W. A. Right lateral (near anterior), B. Posterior, and C. Left lateral views. ×3 (approx.). Photo. I.A.B.

Fig. D. Australian Museum Specimen No. F.28030, showing plates of an Echinoderm, described by Mitchell, 1897 (PROC. LINN. SOC. N.S.W., 22 (2): 258-259), as *Palaechinus* sp. Upper Silurian. Middle Trilobite Bed, Bowning Village, west of Yass, N.S.W. ×3·7 (approx.). Photo. I.A.B.

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